Retaining Ligaments of the Digits of the Hand

GROSS AND MICROSCOPIC ANATOMIC STUDY

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Foreword

The importance of skin ligaments or retaining ligaments of the *fingers of the hand was not recognized by the early anatomists*, and even the existence of these ligaments per se was not known, or, if observed, was not mentioned in the existing texts of the classical anatomists These ligaments were apparently first mentioned in 1742 by J Weitbrecht, who was possibly the first to unify the study of ligaments under the name of syndesmology Cleland and Grayson contributed greatly to the understanding of these structures and, to a certain extent, their function Studies and observations made by anatomists in France and elsewhere continued to add to the available knowledge, however the greatest advances were made by Landsmeer, who not only introduced additional morphological data, but developed mechanical concepts which explained the functional phases of action of the fingers In the meantime, the development and rapid progress of surgery of the hand imposed the requirement of great precision in the understanding of the rhythm of action resulting from the combined participation of the intrinsic and extrinsic muscles, the joints with their ligaments, and the special connections of the various tendons and the skin In spite of the knowledge acquired, more was necessary for understanding the morphology of the retaining ligaments

This study on the retaining ligaments represents a successful effort to combine a thorough investigation and an excellent method to create a morphologically true picture of the ligaments, their

development and action The study will eliminate many doubts in the interpretation of structures which have been variously described It will help the hand surgeon to recognize more readily the anatomy of normal and injured structures and will help him to devise more successful surgical procedures The natural color illustrations add precision and eliminate the imaginary interpretive creativity leading to error

With cognizance of the tribulations involved in the search for a true morphological picture of the retaining ligaments it can be stated that the present work will be of inestimable help in the understanding of an important phase of the anatomy of the hand

EMANUEL KAPLAN

Appreciation

I wish to express my sincere appreciation to Dr Emanuel B Kaplan for his continual help and inspiration Through the years, his teaching and friendship have been cherished Recently, his personal interest in this study has been not only extremely helpful but gratifying

I also would like to thank my partner, Dr A Hoyt Crenshaw, for the generous giving of his time and talent in helping in the presentation of this study in a more readable form His assistance far exceeded what might have been expected from a pleasant relation ship with an associate

LEE W MILFORD, JR

Contents

V

VI

VII

I

Introduction

The study presented here concerns the retaining ligaments of the digits contributing to function by maintaining the position of the skin and regulating the extensor mechanism over the dorsum of the digits. I have not intended a discussion of the origin or insertion of the extensor or flexor tendons or the strong, collateral ligaments of the finger joints, so well described already by Kaplan.[7,10]

The term "retinacular ligament" has not been used in the title because a specific ligament already bears that name; actually, there are many ligaments functioning as retinacular (L-halter) or retaining ligaments. The ligaments included in this study are commonly known as Cleland's cutaneous ligament, Grayson's ligament, the retinacular ligament of the extensor tendon and the oblique fibers of Landsmeer or link ligament of Haines, and the sagittal band also known as the shroud or sling ligament.

The purpose of this study is to describe again the anatomy of these ligaments and their structural interrelationships, by personal investigation and by comparing my findings with the descriptions and illustrations of original observers. We have adapted the nomenclature for these structures as shown in Figure 1, which shows all the ligaments included in this study except for that of Grayson. Since the original descriptions are not immediately available to most readers, the classic articles will be quoted extensively to give accurate bases for comparison. An attempt was made to illustrate accurately the anatomy of these ligaments, by the use of color photography of the microdissection and by serial microscopic sections. Several new observations are made about the origins of these liga-

ments, the orientation of their fibers, and their insertions in the finger A ligament not previously described but similar to the oblique retinacular ligament in the fingers was also found in the thumb (Fig 34) The name "oblique retinacular ligament of the thumb" is suggested

These ligaments are becoming recognized as being of more and more clinical importance as their function and gross structures are better understood Their surgical manipulation in the past has not been limited by instrumentation or by the coordination of the surgeon's hand, but by a lack of understanding Anatomists have been in some general agreement about the description of these small structures, however, they are illustrated for the most part by diagrams only (Figs 2 to 6), which do not show the important relationships better observed in an actual photograph (Fig. 7)

II

Materials

Ten fresh frozen, human, adult amputated hands were collected over a period of years to furnish the anatomic material needed for this study All fingers and thumbs of eight hands were dissected carefully, and serial microscopic sections were made of the digits of the other two This study was carried out specifically to identify these retaining ligaments and to observe their configurations Various magnifications were used during dissection, from a one diopter lens to a lens of three magnifications The instruments used for dissection were those tools of low tolerance normally used in hand surgery

The gross dissection was carried out on each of the 32 fingers and eight thumbs of eight complete hand specimens Both sides of each digit were dissected, beginning either on the extensor or the flexor surface through an off centered longitudinal incision to avoid severing exact midline structures The dissection was carried out by peeling the skin toward the volar or dorsal side while carefully ob serving the attached structures Each specimen was held securely by an assistant on a firm, rigid surface under operating room lights

In preparation for the microscopic studies, two hands while still frozen hard, were cut on a band saw One was cut so as to pro vide transverse sections of all parts of each finger and thumb Later, these sections were decalcified and cut and stained for microscopic study The fingers and thumb of the other hand were cut along the midlongitudinal axis, and these halves were also fixed, decalcified, and prepared for microscopic study The sections were mounted so that a slide was available for study at each millimeter level, both

transversely and longitudinally (Fig 8) At each millimeter level a hematoxylin-eosin stained section and a Masson or Gomori stained section were processed. Some larger sections required mounts on slides measuring up to 5 by 7 inches (Fig. 9) These slides were studied under a microscope at 25 or 40 magnifications Study was also carried out using a back lighted view box and a hand magnifying lens Microphotographs of certain areas of the slides were made at 25 times magnification this in general was too much magnification to demonstrate one entire gross structure Color photographs and prints of entire slides were made to illustrate some of the structures

III

Classic Descriptions of Retaining Skin Ligaments

Professor Cleland, a Scottish surgeon of Glasgow, stated in *The Report of the Proceedings of the British Association* at Dundee in 1867 that " strong ligaments, hitherto undescribed, extend from the sides of the phalanges, near the phalangeal articulations, and are inserted into the skin, helping to retain the different parts of the integument in the position to which they are adapted to occupy "

He later published, in 1878, a more detailed description of this ligament [3] In the second paragraph of this publication he states

> These ligaments are very constant structures and it is strange, seeing that they are obvious and strong, that they have not attracted attention Those at the first interphalangeal articulation of the fingers are exceedingly well developed, as also those at the interphalangeal joint of the thumb and an arrangement similar in kind, though less distinct can be seen at the distal joints of the fingers, and also in the toes

Indeed they are obvious and strong Further, they had already attracted the attention of Weitbrecht[15] in 1742 Weitbrecht's description of them, according to Kaplan,[10] was very similar to that generally accepted today

Certain observations from Cleland's classic description are

of interest He does not indicate the number of hands that he actually dissected although he states that the ligaments are constant structures and are present in the thumb as well as in the toes According to his illustration (Fig 2) his dissections must have been carried out through a midline incision on the palmar surface of the finger This also explains his statement that the principal band extends upward If the reader keeps in mind that by upward Cleland actually means toward the palmar surface of the finger the descriptions in this third fourth and fifth paragraphs are less confusing

> Describing the ligaments opposite the first joints of the fingers from a specimen before me I find a strong band of fibres arising from the lateral ridge of the first phalanx in the distal half of its extent some of them within and some of them outside the grasp of the ligamentum vaginale binding down the flexor tendon and adjoining this band are a few fibres from the lateral prominence of the base of the second phalanx The strong band thus formed is directed downwards behind the artery and nerve and its fibres spread out somewhat on reaching the skin those on the palmar aspect turning over towards the middle line of the finger Decussating behind this band is one of smaller size arising from the lateral ridge of the second phalanx and inclining upwards by the side of the first phalanx in its course to the integument
>
> At the last joint of the finger the principal band extends upwards from the lateral prominence of the base of the last phalanx and is strengthened by fibres from the rough expansion of the distal extremity of the phalanx while other fibres pass directly to the skin behind this band
>
> The general result may be described as being the formation of a strong fibrous septum on each side of each finger lying immediately behind the palmar digital branches of vessel and nerve

While Cleland s description seems generally accurate it gives one the impression that the ligament is of uniform thickness or that it is a sheet of tissue although he does infer otherwise when he states that its fibres spread out somewhat on reaching the skin Yet again a sheet of tissue is brought to mind when he describes the formation of a strong fibrous septum In my description I will convey my impression that this structure is shaped somewhat like a cone

In a recent publication, Stanisavljevic[15] described a so called "paratendinous apparatus" of the digits, this apparatus being an attachment of the dorsal skin to the underlying extensor tendon, as a "thick layer of tissue " Cleland did not give a detailed anatomic description of these fibers, but did describe their function when he stated that " the main advantage of these ligaments appears to be to retain in their places the parts of the integument at the backs of the joints " I have made a detailed study of these fibers and have described them under the title 'Peritendinous Cutaneous Fibers " These fibers seem to be included in Cleland s original description, since they are the only ones that could maintain the integument on the dorsum of the joints as he describes

Grayson[4] in 1941 pointed out that Cleland had described a distinct fibrous septum that traversed from its origin, dorsal to the digital nerve and vessels, or as Cleland put it, " behind the artery and nerve " Grayson then proceeded to describe an additional fibrous septum volar to the digital nerve and vessels He felt that the function of these ligaments was the same as for those described by Cleland The description of these ligaments in the third paragraph of Grayson's paper is vivid reasonably accurate, and complete However, it belies the *illustration within the article (Fig 6A)* The third paragraph of his article is quoted here

> The volar skin retinacula arise not from the phalanges themselves, but from the flexor sheaths, and they are associated in pairs with each interphalangeal joint Those associated with the proximal interphalangeal joint consist of two pairs of ligaments The proximal members arise from the flexor sheath over the distal third of the proximal phalanx, and the distal pair from the sheath over the proximal third of the intermediate phalanx These ligaments pass respectively in a distal and proximal direction as they go to be inserted into the skin over the sides of the proximal interphalangeal joint In dissections of the distal interphalangeal joint only the proximal pair of ligaments could be demonstrated with certainty It is of interest to note that Cleland described a deep ligament of the distal joint but this is not shown in the figure accompanying his paper, nor was its presence satisfactorily demonstrated in the present investigation

He also states that ". . . in the adult human digit, the volar ligaments are thin and membranous." One does not obtain this impression from looking at the illustration copied from his original article. The volar ligaments may be better understood by studying a photograph of an actual gross specimen (Fig. 10). The illustration published in Grayson's article in 1941 was apparently produced with the help of Frederick Wood-Jones. Grayson thanks him for this in a notation at the end of his article. The illustration was also published in 1942 in the book entitled *Anatomy of the Hand* by Wood-Jones.[16] Later it was copied by Hollinshead[8] and possibly by others. My findings (Fig. 6*B*) are in sharp contrast to this diagrammatic illustration (Fig. 6*A*).

Microdissection of Cleland's Ligament

Cleland's cutaneous ligament consists of four conelike structures arising from an interphalangeal joint on each side of a finger or thumb. These ligaments are made up of dense fibrous bundles that diverge from their origin to insert into the skin (Figs. 1 and 11). As one dissects these bundles, one gains the impression that they constitute a sheet of tissue or a septum, but this is true only of the stronger fibers. After more careful observation, it is found that the fibers are not arranged in one plane only, but actually radiate in two planes, forming a structure shaped somewhat like a cone. This is confirmed by microscopic sections.

The largest bundle originates from the lateral margin of the middle phalanx over its proximal fourth, from the joint capsule of the proximal interphalangeal joint, and from the flexor tendon sheath at this level (Fig. 12). These fibers project in straight lines, are strong, and require sharp dissection to disrupt. For the most part, they project outward from the phalanx in an oblique fashion diverging in two planes to insert in an area of skin larger than the area from which they originate. All fibers of this major bundle insert in the skin at various levels, but all proximal to the distal interphalangeal joint. There are also weaker fibers of this bundle that make their way to the skin of the palmar surface. Most fibers originate deep to the transverse retinacular ligament (Fig. 13), all fibers

pass dorsal to the digital nerve and vessels as originally described by Cleland (Fig 14)

Detailed microdissection of the origin of this strongest and most prominent of the four bundles shows the most palmar fibers originating from the flexor tendon sheath at its most lateral margin, from the gutter between it and the condyle of the proximal phalanx, and from the joint capsule Rarely do fibers of this bundle originate proximal to the condylar area of the proximal phalanx or the distal 10 per cent of the phalanx, most originate at the level of the proximal interphalangeal joint and the proximal fourth of the middle phalanx

Functionally, it is interesting that the most dorsally originating fibers of this bundle become taut when the proximal interphalangeal joint is flexed, because they are stretched over the condyle of the proximal phalanx This lends some stability to the otherwise relaxed skin Likewise, the most volarly originating fibers become taut when the proximal interphalangeal joint is extended The volar skin obviously is less mobile when the interphalangeal joints are extended, chiefly because of the tightening of the volar fibers

The strongest bundle is also seen in the thumb, arising from the junction of the flexor tendon sheath and its insertion into bone It then projects distally and laterally to insert into the skin (Fig 15)

The next largest of these four bundles consists of fibers that originate from the distal fourth of the proximal phalanx along its most lateral border and from the capsule of the proximal interphalangeal joint; thus some have a common origin with fibers of the largest bundles just described (Fig 12) They likewise radiate in two planes, but in a proximal and opposite direction from those of the largest bundle These fibers are shorter than those of the largest bundle since they insert more promptly into the surrounding skin, being more perpendicular to the long axis of the phalanx Because this bundle also consists of fibers that diverge in two planes it is more than just a septum as one may first believe when folding down the dorsal skin from the longitudinal incision It must be emphasized that the two most proximal bundles at first appear to be only septa, because most of their strongest fibers do lie within one plane that projects laterally, these strongest fibers may be all that remains

when dissection is carried out, since the other weaker fibers may have been cut unnoticed

The two distal bundles of this ligament take origin from the lateral aspect of the distal interphalangeal joint (Fig 16) These fibers originate from the bone and capsule over a very small area 1 to 2 mm in the adult finger, just proximal to and distal to the distal interphalangeal joint The strongest fibers take origin from the most lateral aspect of the area and pass almost immediately into the skin laterally and dorsally over the distal interphalangeal joint This is possible because the skin lies almost against the bone at this level there being no intervening fat Some of the fibers of each bundle also pass palmarward into the skin at the distal flexor crease In contrast to the skin attachment about the proximal interphalangeal joint, the skin about the distal interphalangeal joint is held much more rigidly Here it is not easy to see separate fibers one sees only firm attachments to the skin by strong bundles of fibrous tissue, especially over the lateral and dorsolateral aspects of the joint There are other oblique fibers originating from the proximal side of the distal interphalangeal joint, passing obliquely and proximally These, therefore, interlace with those of the largest bundle from the proximal interphalangeal joint area as they traverse distally The most proximal bundle of the distal interphalangeal joint is the more prominent of the two found here, and passes dorsal to the digital nerve and vessels, as do all fibers of Cleland s ligament

My dissection indicates three major differences from Cleland s original description of the ligament I find that the ligament is not merely a sheet of tissue or a septum, that the origin of the strongest bundle is from a different area and that the orientation of the fibers of the ligament is different. Cleland finds ' a strong band of fibers arising from the lateral ridge of the first phalanx in the distal one half of its extent ' I am able to find this major or strongest bundle arising from the proximal fourth of the middle phalanx from the proximal interphalangeal joint capsule and from the flexor tendon sheath but from no more than one tenth of the distal part of the proximal phalanx Cleland writes, and joining this band are a few fibers coming from the lateral prominence of the base of the second phalanx ' These I can find, but I cannot find the origin he describes, from the distal half of the proximal phalanx except for the origin of those fibers that constitute the lesser bundle of the proximal two These fibers, however, project proximally in the

opposite direction from those of the stronger band He may have believed that these two bundles should be considered as one, although their fibers do project in two different and distinct directions, those of the stronger one distally and those of the lesser one proximally This would resolve the dichotomy

Microscopic Study of Cleland's Ligament

Small, round bundles of fibers can be seen in cross sections made just proximal or just distal to the proximal interphalangeal joint These bundles lie in the anterolateral aspect of the finger, just lateral to the sheath of the flexor tendon and anterolateral to the bony phalanx (Fig 17) They are distinct from the surrounding fatty tissue Their course in serial sections made either proximally or distally from the level of the proximal interphalangeal joint is from a more central location near the bone to a more lateral location until the skin is reached They pass posterior to the neurovascular bundle and become more anterior and lateral in their position as the sections studied are more distal or more proximal to the proximal interphalangeal joint There are no vessels seen within these bundles None of these particular fibers can be seen distal to the distal interphalangeal joint and none can be seen proximal to the middle of the proximal phalanx

IV

Grayson's Ligament

Grayson[4] in 1941 described a ligament similar to that of Cleland, except that it originates from the flexor tendon sheath, is membranous in character, passes volar to the digital nerve and vessels, and inserts into the skin I quote in part from his article.

> But in addition to these structures it was apparent that there is also a fibrous septum volar to the digital nerves and vessels This septum forms a series of retinacula which, if we refer to Cleland's ligaments as the deep digital skin retinacula might well be termed the superficial or volar retinacula Their distribution is such that they could obviously subserve precisely the same function as their deeper fellows
>
> The volar skin retinacula arise, not from the phalanges themselves, but from the flexor sheaths and they are associated in pairs with each interphalangeal joint Those associated with the proximal interphalangeal joint consist of two pairs of ligaments The proximal members arise from the flexor sheath over the distal third of the proximal phalanx, and the distal pair from the sheath over the proximal third of the intermediate phalanx These ligaments pass respectively in a distal and proximal direction as they go to be inserted into the skin over the sides of the proximal interphalangeal joint In dissections of the distal interphalangeal joint only the proximal pair of ligaments could be demonstrated with certainty It is of interest to note that Cleland described a deep ligament of the distal joint but this is not shown in the figure accompanying his paper, nor was its presence satisfactorily demonstrated in the present investigation

He also states that in the adult human digit volar ligaments are thin and membraneous

Grayson states that Cleland s description of the human condition was verified in every case With this I disagree as already pointed out His illustration (Fig 6A) is a reasonably accurate diagram of the direction of fibers of his superficial retinacula cutaneous ligament and of their origin and insertion however they do not constitute a volar mirror image of Cleland s ligament as his diagram indicates This discrepancy can be seen more clearly by comparing a recently drawn illustration (Fig 6B) with his original one (Fig 6A) Grayson s diagram shows his fibers running obliquely to the skin for their insertion However I found them almost parallel in course and perpendicular to the long axis of the finger (Fig 10)

Microdissection of Grayson s Ligament

One can easily see that the ligament of Grayson is indeed very fragile and membranous in character (Fig 10) It is strongest at the middle three fourths of the middle phalanx in the finger and just proximal to the interphalangeal joint of the thumb The ligament originates from the volar aspect of the flexor tendon sheath Its fibers project at right angles to the sheath pass volar to the digital vessels and nerve and insert into the skin at the same level as their origin These fibers do not spread or fan out like those of Cleland s ligament but tend to be parallel The diagram of Grayson depicting Cleland s ligament is misleading if not erroneous it shows the origin of the major bundle of this ligament to be entirely from the proximal phalanx and the major bundle decussating with the distal bundle at the proximal interphalangeal joint instead of at the distal third of the middle phalanx (Fig. 11) Grayson s illustration shows a distal sheet at the distal interphalangeal joint but omits the distal bundle of Cleland s fibers One must admit however that the diagram of Grayson is much more consistent with Cleland s description than with Cleland s illustration (Fig 2)

Grayson s ligament in the human probably is strong enough only to hold the digital vessels and nerves in place and keep them

from bowstringing when the finger is flexed Clinically, along with Cleland's ligament, they form a tube, from the proximal end of the finger to the distal interphalangeal joint, in which the digital nerve and vessels can always be found during surgical dissection Some of Grayson's fibers are continuous across the midline with those on the opposite side

Microscopic Study of Grayson's Ligament

At the level of the proximal interphalangeal joint, the membranous ligament of Grayson is seen on transverse microscopic section to project laterally from an area immediately volar to the flexor tendon sheath (Fig 17) It forms a loose reticular network, almost like a spider web, that is less dense where it encloses the digital nerve and vessels Its fibers are continuous across the midline and are attached to the deep dermal areas of the skin mid laterally Most of the fibers proceed volar to the nerve and artery This arrangement is fairly constant as serial sections are studied from the proximal to the distal end, until the area distal to the insertion of the profundus tendon is reached Here this network is absent Here, too, no single major artery is found, but only many small branches within the touch pad of the finger

The dissector can well understand why demonstrating this ligament grossly is so difficult, after observing microscopically the fine mesh or reticulation seen in transverse sections Longitudinal sections made to show this ligament were disappointing

V

Peritendinous Cutaneous Fibers

The function of peritendinous cutaneous fibers but not their anatomy has been described accurately by Cleland [5] The following is quoted from him

> The main advantage of these ligaments appears to be to retain in their places the parts of the integument at the backs of the joints Behind each joint the character of the integument *is different from that on the phalanges having thicker epithelium and being thrown into permanent wrinkles on extension of the joint besides being entirely free from hairs* Each of these districts of integument has within its limits ample provision for the flexion of the joint and indeed the apparent redundancy of integument in extension of the joint may be considered as in some measure a consequence of its being stretched in flexion Were the integument not retained in position as it is at the sides of the joints this arrangement could not exist for the flexion of the second joint would displace the skin at the back of the first joint and the flexion of that joint would in turn drag much more of the skin over the knuckles in the same inartistic way in which a glove is dragged and such a displacement actually occurs to a limited extent in hands which from any cause have the integument unusually loose and baggy But generally there is no such displacement the skin over each phalanx retains its position accurately and is put on the stretch when the fingers are bent

The function described above can be carried out only by these so called peritendinous cutaneous fibers These fibers are generally weaker than those arranged along the lateral aspect of the fingers They arise from the extensor mechanism and insert almost

entirely at the level of the dorsal skin folds over the proximal and distal interphalangeal joints (Fig 18), they are much less distinct at the metacarpophalangeal joint The strongest fibers lie along the dorsolateral aspects of the interphalangeal joints, these fibers are the same as those described in an earlier section and referred to as the distal bundles of Cleland s ligament Many of the other fibers can be disrupted by blunt dissection. They are almost nonexistent over the extensor tendon at the level of the diaphysis of the proximal phalanx Many strong fibers arise at the level of the proximal interphalangeal joint in the midline and insert into the skin at its crease over this joint (Fig 19) Another set of fairly strong fibers arises from the triangular ligament of the extensor mechanism over the diaphysis of the middle phalanx, and still another set makes up a pair of bundles one on each side of the distal interphalangeal joint These latter bundles consist of very strong short fibers and insert more heavily into the skin on the lateral most aspect of the joint area, these fibers require sharp dissection to disrupt

With this logical arrangement, the tendinous portions of the extensor mechanism are relatively free of peritendinous cutaneous fibers thus leaving these portions free to glide unencumbered by any strong skin attachments The least mobile parts of the extensor mechanism the insertion of the central tendon and the insertions of the lateral tendons, are firmly attached to the skin by such fibers Thus the skin creases are held in position over their respective interphalangeal joints, regardless of the possible demand proximally for more skin coverage (Fig 20) When these fibers are cut however, the skin can be shifted more easily, as is shown in Figure 21 This arrangement of fibers is constant in all fingers and at the interphalangeal joint of the thumb The fibers tend to lie parallel to the skin until the skin is pulled outward, then they become perpendicular to it In normal movement, of course they are pulled parallel to the skin

Microscopic Study of Peritendinous Cutaneous Fibers

These fibers are difficult to identify microscopically As noted in gross dissection they are small in caliber and are arranged in

poorly defined bundles They can be seen just under the dermis, more prominently over the dorsum of the interphalangeal joints In the longitudinal sections, the fibers are not easily separated from the underlying extensor tendon and triangular ligament The fibers lie parallel to each other in their course over the tendon and may be seen projecting obliquely and dorsally to insert principally in the deep dermis over the interphalangeal joints Were these fibers not already demonstrated in gross dissections I do not feel that one could identify them microscopically in longitudinal sections In the transverse sections, however they can be identified more easily, but their orientation cannot be determined they are seen between the extensor mechanism and dermis and form a fine retinacular network in which are located small veins

VI

Retaining Ligaments of the Extensor Mechanism

The retaining ligaments of the extensor mechanism referred to here are those that attach to the lateral margin of the extensor mechanism, at either the proximal interphalangeal joint or the metacarpophalangeal joint The inconsistent attachment of the extensor tendon to the proximal margin of the proximal phalanx and to the joint capsule are not considered in this study

The retaining ligaments at the proximal interphalangeal joint have been called "retinacular ligaments" with 'transverse' and "oblique" components by Landsmeer,[11] the latter being called the 'link ligaments" by Haines[5] and 'retinaculum tendini longi" by Weitbrecht,[15] the transverse component has been called the "fascial sheath" by Bunnell[2] These two components will be referred to in the following descriptive material as the 'transverse retinacular ligament" and the "oblique retinacular ligament"

The ligaments at the metacarpophalangeal joint have been called the "sagittal bands," "the shroud ligaments," or the "volar sling" I will refer to them later as the "sagittal bands"

The Transverse Retinacular Ligament

After completing the gross dissection of 64 retinacular ligaments in eight hands I learned that my findings were in general agreement with the descriptions already published The transverse retinacular ligament is composed of thin strong fascia easily perforated by a dissecting probe but difficult to tear (Fig 22) Its fibers originate from the volar aspect of the capsule and flexor tendon sheath at the level of the proximal interphalangeal joint The fibers then pass superficial to the fibers of Cleland s ligament (which arise in the same area) and therefore may be considered to act as a sling for them (Figs 1 and 13) Some fibers also arise from the skin at the anterolateral aspect of the finger at the level of the flexor crease they may be unknowingly destroyed during sharp dissection However they do broaden the origin of the ligament and they do pass dorsally with the other fibers to form a sheet of fascia that inserts mainly on the lateral margin of the lateral tendon of the extensor mechanism The fibers are oriented perpendicular to the longitudinal axis of the finger Thus they pass over the condyle of the proximal phalanx Some fibers pass distally and obliquely as they curve around the joint capsule and attach further distally on the lateral tendon this makes the ligament trapezoidal when its origin has been detached (Figs 23 and 24) Most of the fibers insert on the lateral margin of the lateral tendon however a few pass dorsally over the extensor tendon and become continuous with those of the opposite side These can be seen well under oblique lighting

Functionally this ligament acts as a stabilizer for the lateral tendon of the extensor mechanism It also seems to pull the lateral tendon volarward when the proximal interphalangeal joint is flexed As this joint is flexed *those fibers that pass just distal to the greatest* width of the condyle of the proximal phalanx are tightened because they are pulled over this area of the condyle The lateral tendon lies dorsal to the fulcrum of the proximal interphalangeal joint and as flexion occurs the tendon is placed under tension until it must slide off the apex of the joint and subluxate laterally It may be considered as being pulled laterally by the transverse retinacular ligament which does not yield to the demand of the lateral tendon to lengthen so that the lateral tendon may remain in its original

position Of course, the lateral tendon itself becomes increasingly tight because of flexing of the joint Because of their eccentric insertion, the distalmost fibers of the transverse retinacular ligament act under the same influence as does the collateral ligament of the metacarpophalangeal joint I do not imply that the transverse retinacular ligament alone is responsible for lateral subluxation of the lateral tendon, for if this ligament is divided, the lateral tendon still subluxates volarward when the proximal interphalangeal joint is flexed

All fibers of this ligament lie snugly against the capsule of the proximal interphalangeal joint in their course from volar origin to dorsal insertion They stand out in relief only after the plane of dissection is found and the sheet is elevated from its bed No strong, discrete, well-oriented fibers can be seen in this thin ligament

The Oblique Retinacular Ligament

Landsmeer in 1949 called attention to the presence of an oblique component of the retinacular ligament One year later, Haines published a description of the same ligament, which he called the "link ligament" for certain functional reasons He did not know until after his article had been written that Landsmeer had already described this ligament Haines refers to Landsmeer's article only by a short notation at the end of the article, it was not included in his bibliography Neither probably realized until after Kaplan pointed out in his second edition of *Functional and Surgical Anatomy of the Hand* that Weitbrecht had described the same structure over 200 years previously and had named it retinaculum tendini longi " Its function, however, has been understood much better since the publications of Landsmeer,[11] Haines,[5] Stack,[12] Tubiana and Valentin,[14] and others

In contrast to the fibers of the transverse retinacular ligament, the fibers of the oblique ligament are tendinous in character This probably was recognized by Weitbrecht when he named the ligament the "retinaculum tendini longi The fibers of this ligament arise from the bone of the distal fourth of the proximal phalanx at the junction of the phalanx and the flexor tendon sheath They form a narrow, strong, tendinous band that passes parallel to the lateral

margin of the lateral extensor tendon and along the longitudinal axis of the phalanx The origin of this band is at times covered by the border of the extensor tendon (Fig. 25) Fibers of the oblique retinacular ligament cross the proximal interphalangeal joint deep to those of the transverse retinacular ligament and are generally quite separate from them A few of the oblique fibers at times insert into the middle of the transverse retinacular ligament but most of them pass deep into it finally to join the lateral margin of the lateral tendon The fibers project distally parallel to those of the lateral tendon of which the band becomes an integral part at about the level of the proximal interphalangeal joint (Fig. 26) Sometimes these fibers can be seen to continue at the lateralmost part of the lateral tendon as it inserts into the distal phalanx The oblique retinacular ligament consistently passes volar to the axis of rotation of the proximal interphalangeal joint when the joint is flexed and thus becomes quite tight when this joint is in extension (Fig. 27)

It has been noted by Haines Landsmeer and Stack that because of its relationship to this axis of rotation the ligament does not allow easy active or passive flexion of the distal interphalangeal joint when the proximal interphalangeal joint is in extension In Figure 28 one sees tension placed on this ligament by a hook while the proximal interphalangeal joint is in flexion The flexed position of this joint would normally permit flexion of the distal interphalangeal joint but here because of the tension on the ligament passive flexion of the distal interphalangeal joint is impossible

Apparently in some cases of arthritis this ligament can become selectively contracted enough to cause constant hyperextension of the distal interphalangeal joint when the proximal interphalangeal joint is only partially extended (Fig. 29) Flexion of the distal interphalangeal joint is impossible after the proximal interphalangeal joint has been extended almost completely (Fig 30) Neither flexion nor extension of the metacarpophalangeal joint alters the necessity for flexing the proximal interphalangeal joint to permit flexion of the distal interphalangeal joint Should the lateral tendon be tight as in an intrinsic muscle contracture extension of the metacarpophalangeal joint would not permit flexion of the interphalangeal joints as is possible here (Fig 31)

Transverse and Oblique Retinacular Ligaments in the Thumb

In the thumb there seem to be transverse and oblique retinacular ligaments At times, there is found a thin, membranous, translucent sheet of fascia that originates from the lateral margin of the flexor tendon sheath at and just distal to the metacarpo phalangeal joint This sheet of fascia immediately spreads out to insert on the entire margin of the extensor tendon over the proximal phalanx (Figs 32 and 33) This structure may help to some degree in maintaining the extensor tendon over the proximal phalanx

The oblique retinacular ligament is represented in the thumb by a small tendinous band originating from a discrete muscle bundle deep within the muscle mass of the abductor pollicis brevis It is also seen in the adductor pollicis The oblique retinacular ligament passes laterally over the metacarpophalangeal joint volar to its axis of rotation when the resting position of slight flexion of the joint is maintained It then passes parallel to the extensor pollicis longus tendon over the distal half of the proximal phalanx and inserts, along with this tendon, into the distal phalanx The fibers of this band are indistinguishable from those of the tendon at their insertion (Fig 34)

Microscopic Study of Transverse and Oblique Retinacular Ligaments

In transverse sections at the proximal interphalangeal joint, many fibers are seen coming from the area around the extensor tendon Although all these fibers project volarward to attach to the flexor tendon sheath and joint capsule, they are not seen as separate bundles or sheets I am unable to identify what I would consider to be the strong, thin fascia making up the transverse retinacular ligament or the small, strong, tendinous structure, the oblique retinacular ligament The latter ligament is so intimately related to the lateral extensor tendon that it cannot be identified microscopically This does not imply that I question its existence This ligament

could be considered to be a part of the lateral tendon but for its separate origin and therefore, different function This origin could not be demonstrated on microscopic section

The Sagittal Band

The sagittal band, also known as the sling ligament, may be considered to be a homologue of the transverse retinacular ligament Its fibers originate from the deep transverse intermetacarpal ligament and constitute the most proximal part of the dorsal expansion of the extensor mechanism The fibers form a strong thin tendinous sheet, and each major fiber is noted to project perpendicular to the long axis of the finger on its way to insert on the lateral margin of the extensor tendon (Fig 35) Some fibers can be seen continuing on over the dorsum of this tendon to become continuous with those of the opposite side The distal part of this wide band fuses with the aponeurotic expansion of the interosseous and lumbrical muscles [1] The proximal border of the band is free

On the radial side of the index finger the sagittal band originates from the base of the proximal phalanx the metacarpal head the side of the flexor tendon sheath's attachments and the volar plate, passing around the metacarpal head outside the capsule Its major fibers pass over the bony insertion of the first dorsal interosseous tendon Fibers originating from the deep fascia at the dorsal margin of the first dorsal interosseous muscle pass separately from the underlying muscle and project laterally to insert into the skin (Fig 36) This ligament forms a roof, under which passes the distal portion of the first dorsal interosseous muscle its fascia and tendon it has no specific name

A similar arrangement is also found at the ulnar side of the little finger for the abductor digiti quinti tendon

The sagittal band passes deep to the tendon of those intrinsic muscles that insert into the aponeurotic expansion of the extensor mechanism

In no instance could there be seen fibers perforating the transverse intermetacarpal ligament the flexor tendon sheath, and its underlying ligament

In the past the sagittal band has been either unrecognized or disregarded in most standard textbooks of anatomy In some it has been illustrated but neither labeled nor described An example of the latter situation is found in the accurate cross sectional drawings by C H Barlow in 1906 in the second edition of Kanavel s classic *Infections of the Hand* Tubiana and Valentin give excellent descriptions and illustrations in their publication [14]

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Illustrations

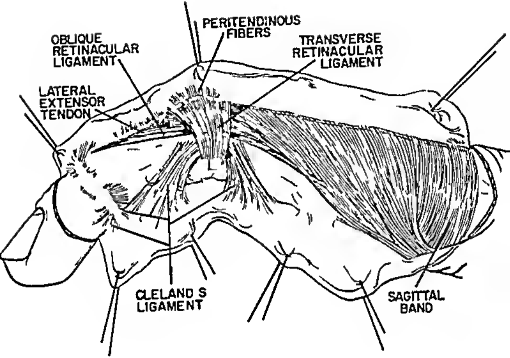

Figure 1

Th s drawing is presented in order to orient the reader to the ligaments under discussion It does not show Grayson s ligament nor does it show the exact anatomical arrangement of the ligaments see photographs and text

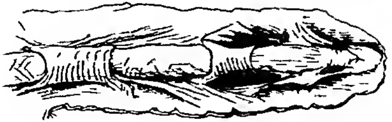

Figure 2

A copy of Cleland's original illustration (J. Anat. Physiol. *12*:526, 1878.)

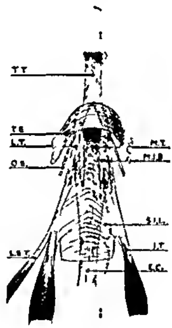

Figure 3

A copy of the original illustration of Landsmeer. The label T.B. indicates *what is referred to in the text as the transverse retinacular ligament.* The label O.B. is referred to in the text as the oblique retinacular ligament. (Landsmeer, J. M. F.: Anat. Rec. *104*:31, 1949.)

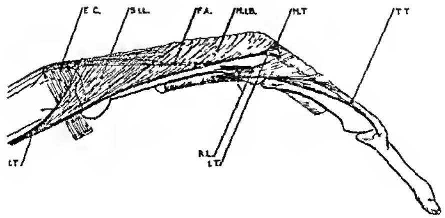

Figure 4

Landsmeer s illustration from his original article Both the transverse and retinacular ligaments are diagramed and are labeled R L (Landsmeer J M F Anat Rec *104* 31 1949)

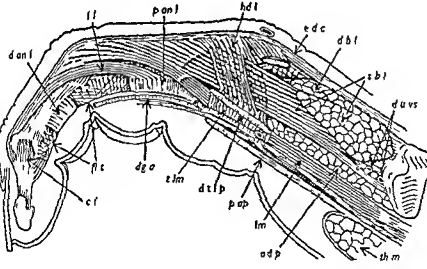

Figure 5

This copy of the original illustration of Haines labels the oblique retinacular ligament l l (Haines R W J Anat *85* 251 1951)

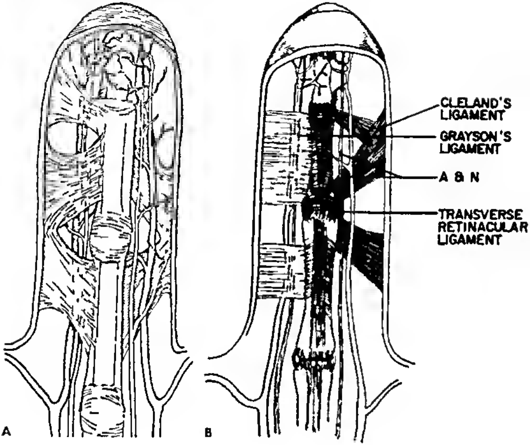

Figure 6

A This copy of the original illustration of Grayson shows his ligament in the lighter shade passing volar to the neurovascular bundle and Cleland's ligament in the darker shade passing dorsal to the neurovascular bundle (Grayson J J Anat 75 164 1941) *B* This schematic illustration of Cleland's and Grayson's ligaments is in sharp contrast to the original illustration of Grayson shown in *A* It is drawn with a similar format for comparison

Figure 7

The entire extensor mechanism of a little finger has been dissected free and spread out. The point of the distal arrow indicates the oblique retinacular ligament, with the almost quadrangular transverse retinacular ligament just beyond. The proximal arrow points to the cut edge of the sagittal band.

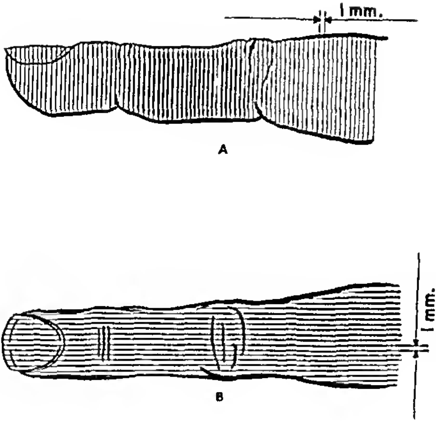

Figure 8

A One microscopic slide was prepared for study for each millimeter of finger length *B* For every millimeter of width a microscopic slide was prepared for study

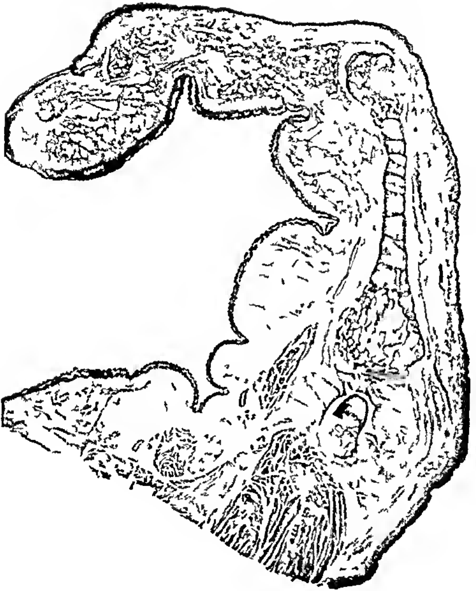

Figure 9

A hematoxylin eosin stained longitudinal section of the middle finger

Figure 10

Grayson's ligament can be seen as a thin fascial partition crossing the finger more prominently at the middle phalanx. It arises from the flexor tendon sheath, passes volar to the digital artery and nerve, and inserts into the skin laterally. Black silk has been threaded along the course of the artery and nerve.

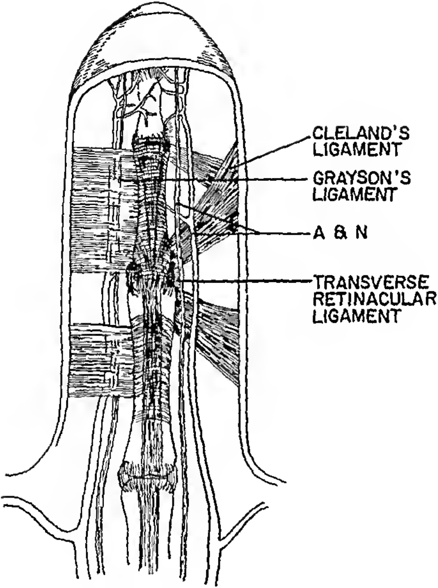

Figure 11

Schematic illustration of Cleland's and Grayson's ligaments.

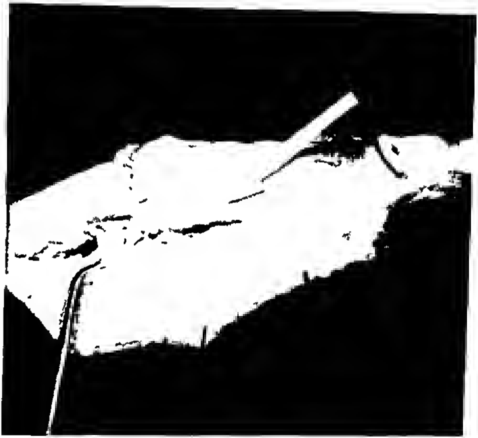

Figure 12

The largest bundle of Cleland's ligament is seen at the point of the arrow. The probe is inserted beneath the second largest bundle.

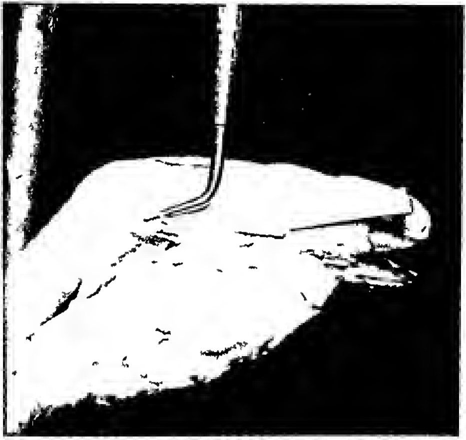

Figure 13

The point of the probe is placed beneath the transverse retinacular ligament. Most of the fibers of the strongest bundle of Cleland's ligament identified by the arrow are seen originating deep to this ligament.

Figure 14

A black silk suture is placed along the neurovascular bundle. The largest bundle of Cleland's ligament is seen at the point of the arrow passing dorsal to this suture.

Figure 15

The arrow points to the strongest bundle of Cleland's ligament as found in the thumb

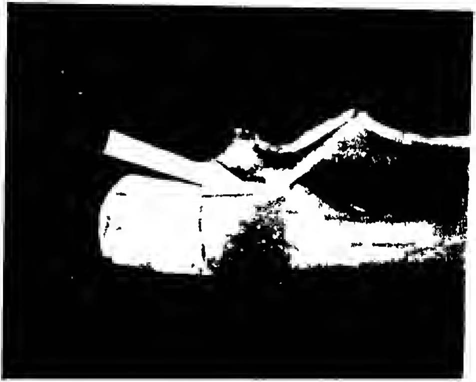

Figure 16

The distal two bundles of Cleland's ligament as seen in the thumb. The arrow points to their origin at the interphalangeal joint.

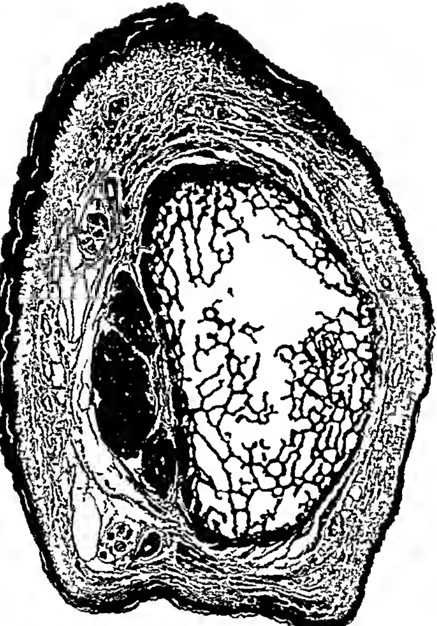

Figure 17

A transverse section through the proximal end of the middle phalanx makes it possible to identify the two slips of the sublimis tendon and the profundus tendon. Lateral to these and lying within a reticular network is the neurovascular bundle. Cleland's ligament consists of the red stained densely packed fibers located anterolateral to the phalanx and posterolateral to the neurovascular bundle. Grayson's ligament consists of the loose reticular network seen just volar to the flexor tendons.

Figure 18

Numerous fibers of the pericutaneous ligament are seen on the dorsum of both interphalangeal joints

Figure 19

The pericutaneous fibers are seen at the point of the arrow. These are much more prominent here at the proximal interphalangeal joint

Figure 20

Prior to cutting the fibers of the per cutaneous l gament the skin is held firmly over the proximal interphalangeal joint resist ng traction by the hook

Figure 21

Following the release of the pericutaneous fibers through a lateral incision the skin can be shifted more freely away from the proximal interphalangeal joint

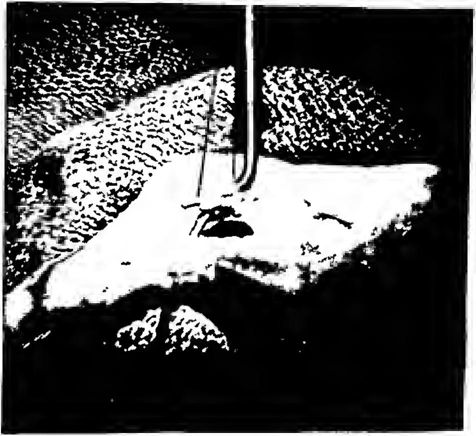

Figure 22

A probe is held under the transverse retinacular ligament. The fibers of Cleland's ligament arise deep to this and project proximally and distally.

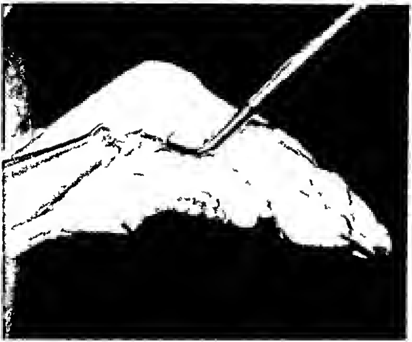

Figure 23

A probe is shown under the fascia like transverse retinacular ligament while a hook places tension on the tendinous oblique retinacular ligament

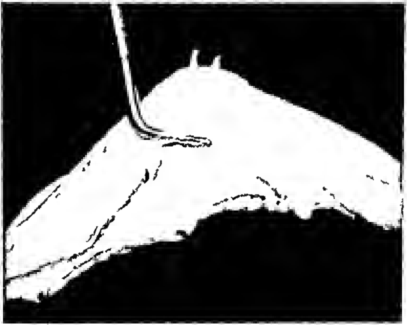

Figure 24

The origin of the transverse retinacular ligament has been cut and held up with two small sutures A probe is placed under the intact oblique retinacular ligament

Figure 25

The origin of the oblique retinacular ligament can be seen at the point of the arrow, quite separate from the lateral extensor tendon here elevated by a hook. The distinctness of its fibers diminishes as it passes beneath the transverse retinacular ligament at the proximal interphalangeal joint but is again seen as the lateralmost fibers of the lateral extensor tendon. Fibers of Cleland's ligament can be seen coming from each side of the proximal interphalangeal joint and inserting into the skin. The fingertip is to the reader's left.

Figure 26

A probe is held under the oblique retinacular ligament after the transverse retinacular ligament has been cut away Its fibers project distally and become a part of the lateral extensor tendon

Figure 27

Extension of the proximal interphalangeal joint tightens the oblique retinacular ligament. The probe demonstrates the tightness of this ligament that causes its distal fibers to stand out along the border of the lateral extensor tendon. Both ligament and tendon insert at the base of the distal phalanx and here are holding the distal interphalangeal joint in extension.

Figure 28

Increased laxity of the oblique retinacular ligament results from flexion of the proximal interphalangeal joint however tension maintained here by the probe *prevents flexion at the distal interphalangeal joint as other* wise would be possible by the downward pressure of the retractor seen at the base of the fingernail

Figure 29

Hyperextension of the distal interphalangeal joint and flexion of the proximal interphalangeal joint are seen when the hand assumes a resting posture, suggesting some abnormal balance

Figure 30

The proximal interphalangeal joint although held almost completely extended does not permit even slight flexion of the distal interphalangeal joint because of increased tightness of the oblique retinacular ligament This ligament is the only tendinous structure that crosses only the distal interphalangeal and proximal interphalangeal joints This situation is not altered by flexion of the metacarpophalangeal joint

Figure 31

Hyperextension of the metacarpophalangeal joint does not prevent flexion of the proximal interphalangeal or distal interphalangeal joint. Intrinsic muscle contracture or tightness of the lateral extensor tendon would limit flexion of the proximal interphalangeal joint. This test position does not eliminate tightness of the oblique retinacular ligament.

Figure 32

In the thumb at the metacarpophalangeal joint a very delicate fascial membrane can at times be demonstrated. This I consider to be the transverse retinacular ligament of the thumb

Figure 33

A dorsal view of the thumb shows a continuation of the transverse *retinacular ligament to the distal phalanx*

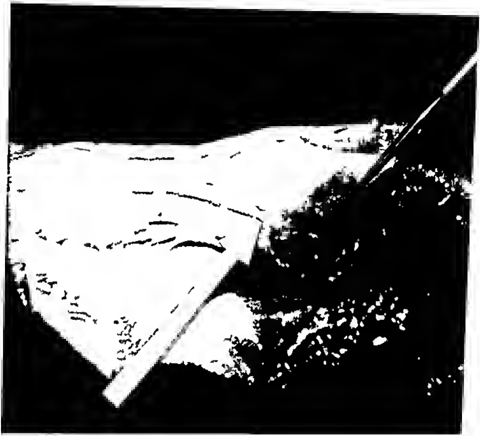

Figure 34

The arrow points to what I consider to be the oblique retinacular ligament in the thumb

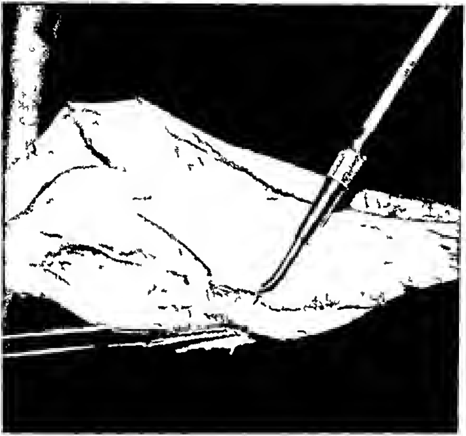

Figure 35

The sagittal band has a free proximal border as demonstrated here by a probe holding the entire ligament in relief It arises from the transverse metacarpal ligament hugs the metacarpal and inserts into the extensor mechanism and into similar fibers from the opposite side The fingertip is to the reader s left

Figure 36

The probe is seen held under the sagittal band at the radial side of the left index metacarpophalangeal joint. At the arrow other fibers are seen more proximal passing around the muscle and fascia of the first dorsal interosseous to insert into the skin. This consistently present ligament has no specific name as yet.